Today, pure powdered orange and grapefruit juices are being made commercially, the accomplishment of a decade of research. And it should not be long before other fruit juice powders take their places in the American home

FRUIT JUICE POWDERS

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A DECADE ago, reference to a fruit powder would probably have called to mind a product consisting largely of sugar, artificially flavored and colored. Today, pure powdered orange and grapefruit juices are being made commercially. The advantages of these powders—in convenience, light weight, and flavor stability—have stimulated interest in similar products from other beverage fruit juices such as apple and grape.

Unfortunately it is not feasible to apply exactly the same drying techniques used for citrus juices to the juices of noncitrus fruits. In the former much of the characteristic flavor (aroma and taste) is in an oil, found abundantly in the peel. When some of this oil is formed into a solid emulsion with sorbitol it can be ground and added to the powdered juice. Thus on reconstitution the juice possesses a characteristic flavor. In contrast, the volatile flavors of the apple and grape are dissolved in their juices. Unless special techniques are employed, they will be lost in the vacuum-concentrating which precedes drying.

It was about 10 years ago that a commercially feasible process for recovering fruit juice aroma in a concentrated or "essence" form was developed by the Eastern Utilization Research Branch.[1] The process consists simply of stripping the aroma from the juice by vaporizing from 10 to 40 percent of its volume with such rapidity that no flavor damage results, even at atmospheric pressure, and simultaneously concentrating the released vapors by fractional distillation to an aqueous essence. The essence is usually concentrated to about 150 times the flavor strength of the original juice..

This basic process has enabled the production of various types of full-flavor concentrated products from noncitrus juices. Full-flavor, 4-fold [2,3,4] and 7-fold [5,6] liquid concentrated apple and grape juices have been described, some capable of room-temperature storage[7]. In preparing them, the essence is made as described above and the stripped juice is vacuum-concentrated to the desired degree. The essence is then restored so that on reconstitution with water a beverage juice possessing the characteristic fruit flavor is obtained. If the stripped juice is to be concentrated to as high a degree as 7-fold, it must first be depectinized.

Progressing from superconcentrated (7-fold) juices to a powdered juice entails much besides removing more water (superconcentrates contain about 27 percent water, and powders about 2 percent). One problem is that of restoring the flavor essence to the product. It is impractical to add aqueous essence directly to dry powder without increasing the moisture too much. The problem was overcome initially in the case of apple, grape, and cherry juice powders* by concentrating the juices to about 80 percent solids, adding an amount of sugar in some cases equal to that of the fruit solids present, adding a fruit acid for palatability, and then reincorporating the essence.

It was found that with the added sugar the concentrate could be dried under vacuum in a tray drier to produce powders which on reconstitution retained the volatile aroma to a surprising degree[8,9]. The added sugar contributes to the keeping properties of the product, since it does not itself enter into the reactions which develop off-flavors. At the same time it dilutes the more reactive sugars and amino acids that may interact to damage flavor. Also, the cost of the product is reduced by substituting some sucrose for the more expensive juice solids.

The dried concentrate is a hard candy which must be ground to a coarse powder. To prevent caking during grinding, its moisture content should not exceed 2½ percent. The high sugar content of the concentrate makes it exceedingly hygroscopic, so that it must be ground and packaged in a low-humidity atmosphere. To prolong its shelf life and prevent caking in storage, the powder is hermetically sealed in tins with an envelope containing a desiccant that weighs one-tenth as much as the powdered juice[10,11,12]. A four-ounce can holds about 100 grams of this powder which, when stirred into 5 equal parts of cold water, dissolves in about one minute to produce a flavorful fruit-juice beverage.

One of the incentives for converting a fruit-juice concentrate to powder is to improve its keeping properties at elevated temperatures. The removal of substantially all of the water, by the combined action of drying and in-package desiccation, so stabilizes the flavor that apple and grape juice powders can be stored for more than 6 months at 100°F., and for more than a year at 73°F., with no significant change. Powered grape juice made by this method and

ored at room temperature for two ars was given a rating by a uartermaster Corps taste panel al- ost as high as that given to the shly prepared product.

For the desiccant to be most effec- e, the packaged product should conditioned at room temperature about 3 months. After such con- ioning, the moisture content of powder will be so low that subse- ent elevating storage temperatures y be tolerated without caking and h only minor flavor change[13].

Although these powdered juices ve excellent flavor and keeping operties, they were prepared by ch-drying methods. Items in this price range must be produced a continuous process to be com- rcially practical. Noncitrus juices e been dried by high-vacuum fing techniques[12] similar to those v used commercially for orange vder. However, the equipment uired is expensive and some of less heat-sensitive juices such as le and Concord grape do not uire the relatively high vacuum essary for puffing.

continuous method quite dif- nt from these is now under de- pment at the Eastern Branch. his process a concentrate of about percent solids is converted to stantial dryness in a matter of nds. This is accomplished by ing the concentrate downward ugh a special-type evaporator ipped with rotary blades, which the viscous material in a state turbulence, thereby preventing l over-heating. The material is at about 185°F. to the evapor- , where it is concentrated under cuum of 27 inches. Drying is in a molten state. Although product contains only about 2½ ent moisture, it can be pumped the evaporator. Its temper- e may reach 230°F., but the time is temperature is so short that flavor is undamaged.

sence cannot be added before g in this manner; if it were, it d be largely stripped out again. efore essence of about 1000-fold epared, which can be incorpor- into the molten concentrate in proper proportion to restore a without causing any signifi- dilution. In order to "stabilize" high-fold essence, and also to tate its blending with the mol- concentrate, sugar is added to the essence to about 60 percent s. The essence is then injected at a metered rate into the stream of molten concentrate on the positive-pressure side of the pump that withdraws the concentrate from the evaporator. A centrifugal pump located in the line just beyond the point where essence is introduced assures immediate and intimate mixing.

The hot concentrate, now containing its proper quota of essence, is fed directly to chilled rolls, which immediately convert it to brittle flakes. The flakes, because of the sugars present, are of course very hygroscopic; all the operations must be carried out in a low-humidity atmosphere. After crushing the flakes to the desired size, the powder is canned with an in-package desiccant in the same manner as powders prepared by batch drying. When reconstituted with water, the product yields a beverage juice fully equal in quality to that prepared by batch drying.

The principles of the foregoing process might be used to make hard candies with natural fresh-fruit flavors. Although fruit essences have been used in making gum-type candies, they have not so far found use in hard candies because of the volatility of essence at the high temperature at which such candies are usually made.

There are many engineering details that yet remain to be solved before the process can be recommended for commercial use. However, as far as can be told by pilot-plant operations, the process is practical for the less heat-sensitive type of fruit juice. The principal equipment required includes pumps for metering the materials, a Turba-Film evaporator[14], chilling rolls, and grinding equipment. The unit in the pilot plant of the Eastern Utilization Research Branch comprises an evaporator with a heating surface of one square foot and twin chilling rolls, each with a cooling surface of one square foot. This unit with its auxiliary pumps has a capacity of more than 30 pounds per hour of powdered apple-juice product—equivalent to 27 gallons per hour of reconstituted apple-juice beverage.

Judging by the rapid progress that has been made recently in developing fruit-juice powders, it should not be long before they find their

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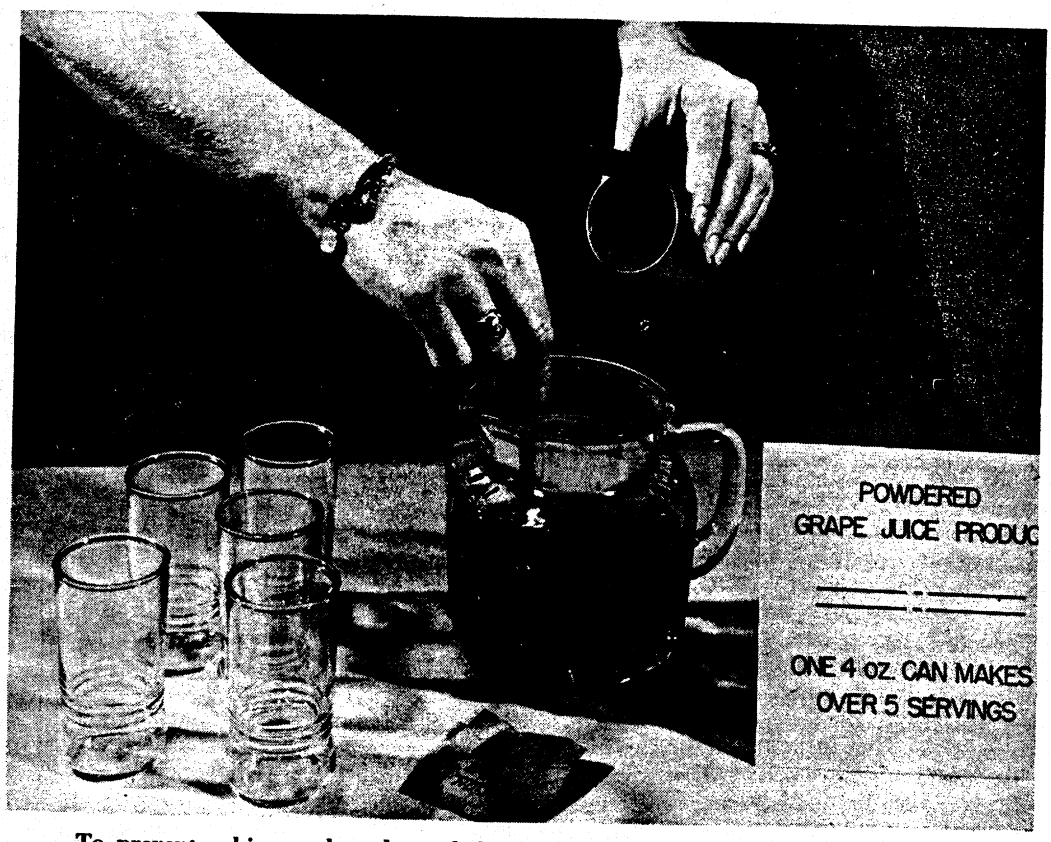

To prevent caking and prolong shelf life, the fruit juice powder is hermetically sealed in tins with an envelope containing a desiccant that weighs one-tenth as much as the powdered juice. A four-ounce can holds 100 grams of powder which, when stirred into five equal parts of cold water, dissolves in about one minute to produce a flavorful beverage

of the Council comes from a portion of the incentive payment due producers as a result of the operation of the main body of the act. This Act recognizes the strategic importance of domestic wool production and establishes a goal of 300,000,000 shorn pounds as the desired minimum. It provides encouragement to producers by establishing an incentive price level. If the National Average Price for wool does not meet the incentive level, 70 percent of the specific duties collected on imported wool is used to make up the difference.

The growers decided by a referendum vote to activate Section 708 and add "a second string to their bow" by using a part of this incentive payment in a "self-help" program to promote and advertise wool and lamb.

This idea of promoting the products of the sheep industry is not new. The National Wool Growers Association's files are replete with reports of promotion efforts starting back in 1918. Never in the history of the industry has it been possible to unify the industry to a point where sufficient funds were available for this work until the passage of the National Wool Act of 1954 and the activation of Section 708 of this Act.

The program is broad and complex and it covers two entirely different products, one in the shelter field—WOOL, and the other food—LAMB. This story will be devoted to the lamb aspect of the efforts of the American Sheep Producers Council.

Since the marketing research activities for this effort are being conducted by the U.S.D.A., as before stated, a brief resume of the fields of endeavor may be divided into the following:

(1) Determination of the pattern of distribution of lamb in the United States; (2) the availability of the product in the retail stores; and (3) the consumer acceptability of the product in different areas of the country. All three studies are under way at the present time.

Preliminary results are beginning to point up some of the problems. For example, at the present time 70 percent of the lamb is consumed by 36 percent of the population in six states. This means that the remaining 42 states, having 64 percent of the population, are eating less than 30 percent of the lamb produced.

Much information is being developed on the amounts of lamb sold, bought and served in the United States, but little is known as to the reasons "why". To most effectively promote lamb, the answers as to why people like or dislike lamb are greatly needed. Therefore, motivational studies are under consideration for this initial period.

The first promotion effort will get under way around the middle of January 1956 in Denver, Colorado, and will tie in with the push being given lamb, on a national basis, by the National Live Stock and Meat Board in cooperation with all retail groups.

Following the Denver promotion, consideration is being given to other regional promotions of high, intermediate, and low consumption. Birmingham, Alabama, is being considered—an area of very low consumption; cities in California are under study; also cities in Texas. Cleveland, Ohio, where the U. S. Department of Agriculture has already conducted consumer acceptability studies on lamb, is being considered for activity in the summer of 1956.

To aid the regional promotions and other cooperative efforts, point-of-purchase materials will be used. Publicity on both a national and local basis will be developed. Field merchandising men will be made available to aid in the promotion activities and to assist the retailer. Displays and exhibits will be developed. Advertising, other than in the test areas, during the initial period will be confined mainly to institutional and trade advertising.

All in all, a well-rounded program is being developed. No one should expect phenomenal results, but it can be said that the sheep industry in its "self-help" program is facing up to its problems.

Fruit Juice Powders

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place beside the other concentrated foods that are contributing so much to added convenience in the home kitchen.

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[1]Howard P. Milleville and Roderick K. Eskew, "Recovery and Utilization of Natural Apple Flavors," U. S. Dept. Agr. and Ind. Chem. Circ. AIC-63; 13 pp. (1944), with supplement, 2 pp. (1945).

[2]L. H. Walker, C. C. Nimmo and D. C. Patterson, "Preparation of a Frozen Apple Juice Concentrate," FOOD TECHNOL., *5*, 148 (1951).

[3]Roderick K. Eskew, G. W. Macpherson Phillips, Richard P. Homiller, Clifford S. Redfield and Rudolph A. Davis, "Frozen Concentrated Apple Juice," IND. ENG. CHEM., *43*, 2397 (1951).

[4]R. K. Eskew, G. W. M. Phillips, R. P. Homiller, and N. H. Eisenhardt, "Preparation of Full-Flavor Frozen Grape Juice Concentrates," U. S. Dept. Agr., Bur. Agr. Ind. Chem. Arc. AIC-301; 7 pp. (1951).

[5]Roderick K. Eskew, C. S. Redfield and G. W. Macpherson Phillips, "High-Density Full-Flavor Apple Juice Concentrate," U. S. Dept. Agr., Bur. Agr. Ind. Chem. Circ. AIC-315; 17 pp. (1951).

[6]Roderick K. Eskew, Clifford S. Redfield, Nelson H. Eisenhardt, Joseph B. Claffey and Nicholas C. Aceto, "High-Density Full-Flavor Grape Juice Concentrate," U. S. Dept. Agr., Bur. Agr. Ind. Chem. Circ. AIC-342; 15 pp. (1952).

[7]Nicholas C. Aceto, Nelson H. Eisenhardt, Roderick K. Eskew and G. W. Macpherson Phillips, "Storage Characteristics of Apple and Grape Juice Full-Flavor Superconcentrates," U. S. Dept. Agr., Agr. Research Service Circ. ARS-73-3; 5 pp. (1955).

[8]Roderick K. Eskew, Howard I. Sinnamon and Victor A. Turkot, "Powered Grape Juice," FOOD TECHNOL., *8*, 27 (1954).

[9]Howard I. Sinnamon, Victor A. Turkot, Roderick K. Eskew and G. W. Macpherson Phillips, "Powder Makes A-1 Apple Juice," FOOD ENGINEERING, *26*, 78, July 1954.

*Designation of the products described here has not as yet been made by the Food and Drug Administration. The terms used here are for purposes of description without implication of what labelling might be required in commercial use.

[10]Louis B. Howard, "Desiccants Improve Dry Packs." FOOD PACKERS, *26*, 31, March 1945.

[11]Louis B. Howard, "Factors of Processing and Storage That Affect Quality," CANNER, *100*, 46, Feb. 24, 1945.

[12]S. I. Strashun and William F. Talburt, "Puffed Powder from Juice," FOOD ENG., *25*, 59, March 1953.

[13]Victor A. Turkot, Howard I. Sinnamon, Roderick K. Eskew and G. W. Macpherson Phillips, "Storage Behavior of Powdered Apple and Grape Juice Products," FOOD TECHNOL., *9*, 506 (1955).

[14]Recommendation of this specific product is not implied. Products of other manufacturers may be equally effective.